

## BELLCOMM, INC.

955 L'ENFANT PLAZA NORTH, S.W.

WASHINGTON, D. C. 20024

SUBJECT: Apollo Camera Resolution Tests  
Case 340

DATE: March 6, 1969

FROM: A. F. H. Goetz

MEMORANDUM FOR FILEI. INTRODUCTION

Film from three different magazines, exposed during the Apollo 8 red-blue color experiment, showed all red frames to be severely out of focus. This phenomenon had not been anticipated. However, all frames were taken after trans-earth injection with the 250 mm lens, instead of the 80 mm lens as planned. Lens resolution measurements were carried out at MSC by the author on the Apollo 8 flight hardware to clarify the focus problem.

II. RESOLUTION MEASUREMENTS

Measurements were made in the Flight Crew Support camera facility at MSC with the assistance of R. Thompson. A Gaertner L360n optical bench and collimator and an Air Force resolution target were used. Using a collimator allows resolution tests to be made at the camera focus setting, the same used during flight.

Tests were conducted using camera back and 80 mm lens no. 1020, 250 mm lens no. 11, magazine G no. 123 and type 3400 film. The twin filter slide holder (TFSH) no. 1001, carrying the standard 47B (blue) and 29 + 0.6ND (red) filters was used.

Focal length tests were also made by placing a microscope near the image plane of the camera. Assuming a nominal focal length without a filter, the 80 mm lens focuses at 80.02 mm in the blue and at 79.82 mm in the red. The 250 mm lens focuses at 250.22 mm in the blue and 249.62 in the red. The red focus was difficult to locate and was nowhere sharp. This fact was borne out in the resolution tests.

III. RESULTS

Table I lists the results of the resolution tests. Since a number of frames were overexposed, some values will appear low. Overexposure is denoted by a + sign after the

(NASA-CR-103987) APOLLO CAMERA RESOLUTION  
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ABSTRACT

Lens resolution tests were made to determine the cause of the out-of-focus images found on Apollo 8 film used in the red-blue filter experiment. It was found that the 250 mm lens does not focus properly in the red. It is recommended that only the 80 mm lens be used in any future color experiments.

value. In the case where both red and blue values were overexposed, the same exposures were used in each case.

TABLE I

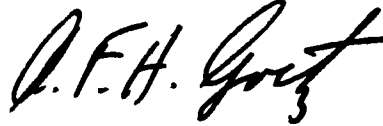
Focus	f stop	Resolution lines/mm for filter			lens
		none	red	blue	
$\infty$	2.8	----	36	36+	80 mm
$\infty$	4.0	80	57	57	"
$\infty$	5.6	----	----	50+	"
Between $\infty$ and 50 ft. 1/4 from $\infty$	2.8	----	32+	40	"
1/2 between $\infty$ and 50 ft.	2.8	----	25+	40	"
50 ft.	2.8	----	completely out of focus		"
$\infty$	5.6	13+	5+	40+	250 mm
1/2 between $\infty$ and 200 ft.	5.6	----	8+	23+	"
200 ft.	5.6	----	9+	8+	"
150 ft.	5.6	----	completely out of focus		"

#### IV. DISCUSSION

The source of the red, out-of-focus images is now quite apparent. The 250 mm lens used aboard Apollo 8 is obviously a poor achromat showing a resolution of only 5 to possibly 15 lines/mm at 6330 Å. On the other hand, the 80 mm lens appears to be well suited for lunar color measurements, exhibiting, at f/4, 57 lines/mm resolution in both the red and blue wavelength regions.

V. RECOMMENDATIONS

In view of the good quality of the 80 mm lens, it should be used exclusively for lunar color measurements. When possible, the lens should be stopped down to f/4 instead of f/2.8. If the 250 mm lens is used for high resolution, black and white photography, it is suggested that a filter, such as a Wratten #64, be used to block long wavelength energy and sharpen the image.



A. F. H. Goetz

2015-AFHG-kse

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